# Biological control general_final

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# Biological Control

# Biological Control Principles

# BIOLOGICAL CONTROL

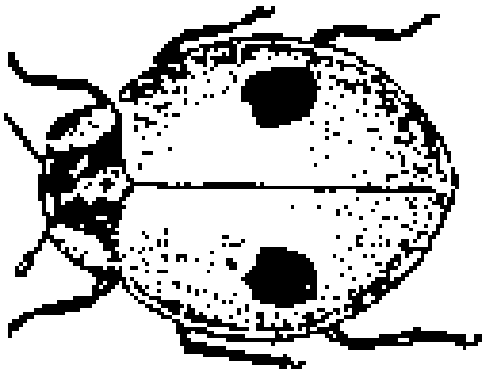
1. Definition
2. Natural Control Vs Biological Control
3. History
4. ecological approach
5. Principles
6. Types (Agents)
7. Strategies

# Natural Control

# Biological Control
## Definition

"The use of living organisms to suppress the population of a specific pest organism, making it less abundant or less damaging than it would otherwise be"

(Eilenberg et al., 2001)



# Biological Control

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First major biological control success was the cottony cushion scale in CA

Cottony Cushion Scale (*Icerya purchasi*) discovered in Menlo Park 1868 on acacia

CA's new citrus industry was mostly around LA
- took 3-4 yrs before it appeared on citrus in LA

By 1880 it was throughout CA - almost wiped out the citrus industry

Chemical measures (cyanide fumigation) had only limited effect

Cottony Cushion Scale (*Icerya purchasi*)

C.V. Riley (USDA) speculated and confirmed that CCS was from Australia

Riley procured funds and sent Albert Koebele to AU in 1888

Keobele found a parasitic fly (*Cryptochetum iceryae*) and a predacious lady bird beetle (*Rodolia cardinalis*) [formerly *Vedalia*]

# *Rodolia cardinalis*

# *Rodolia cardinalis* larvae


Cottony cushion scale and vedalia
Cottony cushion scale with vedalia eggs
Larva
Adult and pupa


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Shipped to SF, reared, then released in tents in LA (140 beetles)

Beetle quickly established, spread, and provided complete control within 2 years

Parasitic fly also became established and is primary control agent in coastal areas

Saved citrus industry in CA

# BIOLOGICAL CONTROL

1. Definition
2. ecological approach
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4. Strategies

***Biological control of insect pests.***

- *The biological control of insect pests refers to the use of disease organisms, predacious or parasitic insects, insect-feeding birds, toads and other animals.*

- Any ecological approach to pest and disease control which is not dependent on the use of chemicals
- requires a recognition that
- ***there is no single factor which is responsible for a pest or disease problem***
- and will rely on a range of husbandry practices which promote stability and balance between crops and their pests.

- In particular, an ecological approach should seek to enhance
- the activities of natural enemies of crop pests
- including other insects, animals such as hedgehogs and birds, as well as fungal, bacterial and viral pathogens.

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# Predation & Parasitism

DEFINITIONS (Gullen & Cranston, 2000)

**Predator**. "An organism that eats more than one other organisms (animals) during its life." *Usually larger than prey (exception: social predators).*

**Parasite**. "An organism that lives at the expense of another (host), which it does not usually kill." *Usually smaller than host.*

**Parasitoid**. "A parasite that kills its host." *Usually smaller than host.*

*Biological control* Use of:

1. predators
2. parasites
3. pathogens
4. nematodes

5. may involve:

- foreign exploitation to find natural enemies
- mass release of enemies
- conservation of natural enemies

1. **Which are the characteristics of the organisms used in the biological control method?**
2. ***Types of Natural Enemies***
3. ***Factors affecting the activity of biological control agents***
4. **Which possibilities does this method offer to farmers and what are its limitations? crops and their pests.**

# OBJECTIVES

- Understand the concept of biological control and the theoretical basis on which it is founded.
- Know the principal phases of evolution of biological control.
- Know the relationship between organisms used in biological control and harmful organisms that need to be controlled.

- Know the limitations and benefits of biological control, in particular with reference to:

1. Use of entomophagous insects and mites
2. Microbial control (use of microorganisms: viruses as and bacteria)
3. Use of nematodes.

*Factors affecting the activity of biological control agents*

## *Factors affecting the activity of biological control agents*

1. *A number of factors have been considered as possibly affecting the activity of the organisms used in biological control. Such factors include:*
2. *The characteristics of the pests, such as the type of damage they cause, their mobility, reproductive rate, and dissemination efficiency.*
3. *The characteristics of the cropping system that may influence the likelihood of success of introduction, augmentation, inoculations and also the use of microbial insecticides. These characteristics can be considered under climate, crop duration, scale of planting and cultural/agronomic practices.*

4. *The natural enemy-prey interactions and the host density dependence.*
5. *Weather and environmental conditions .*
6. *Moreover, populations of natural enemies, like those of pests, are subject to a number of factors which limit their activity. So, in order to forecast the effectiveness of a control intervention, it is necessary to know the needs and characteristics of the pest and its natural enemy*
7. *the diversity of plant species and structure within the field, including temporal and spatial arrangements;*
8. *the composition, management and permanence of surrounding plant communities;*

## Types of biological control agents

- Insects, mites, nematodes and microorganisms are natural enemies of phytophagous insects and are used in biological control.
- Each of these organisms has a different relationship with the harmful insects:

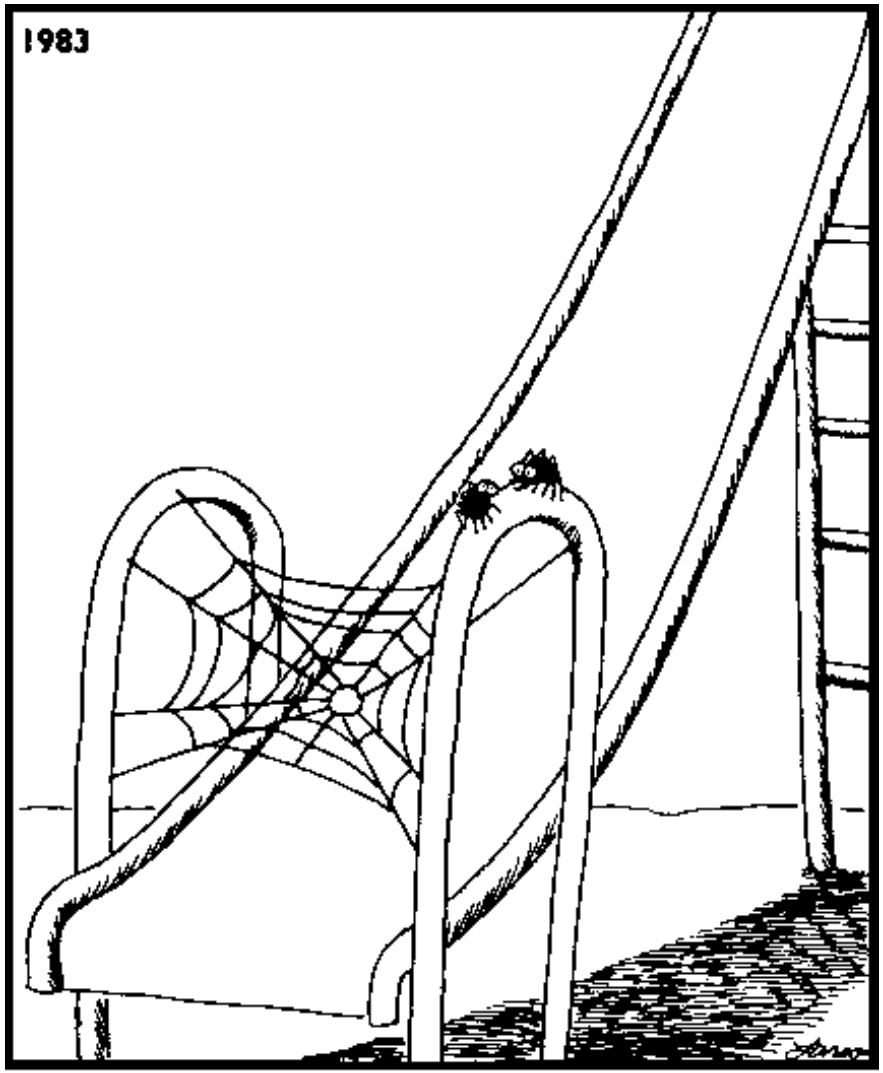
## Entomophagous insects.

Entomophagous insects are the major agents used in biological control. They are classed as either predators or parasitoids, each with completely different characteristics, which contribute to their effectiveness as biological control agents.

# Biological Control

- The use of living organisms to control pests

- Predators
- **Parasites**
- **Pathogens**




"If we pull this off, we'll eat like kings."

# Predators

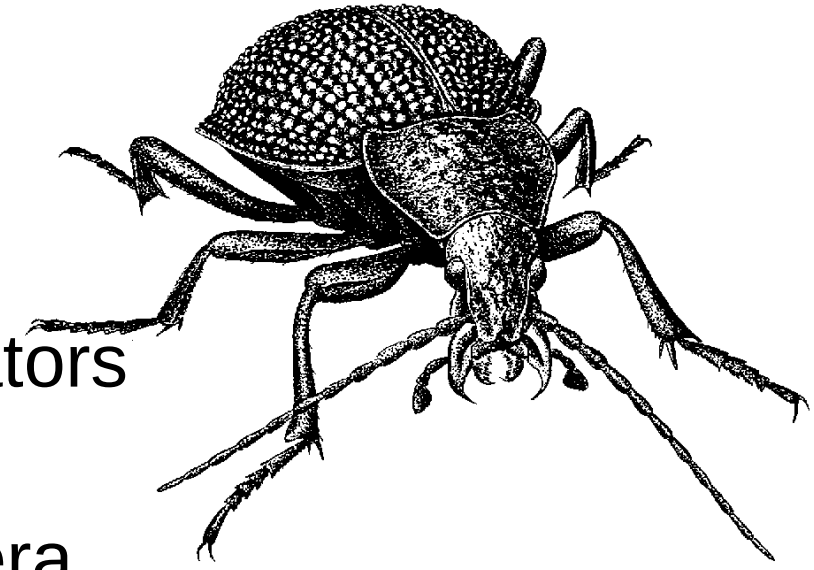
- **Kill many individuals of prey**
- **Often generalists rather than specialists**
- **200,000 species**

# Predators

- **General Rule**
  - **Bigger**
  - **Badder**
  - **Fewer**

# Predators

- Feed on all stages of prey
- Predators kill more than one individual
- Not highly specialized
- Chewing and sucking predators
- More than half are Coleoptera



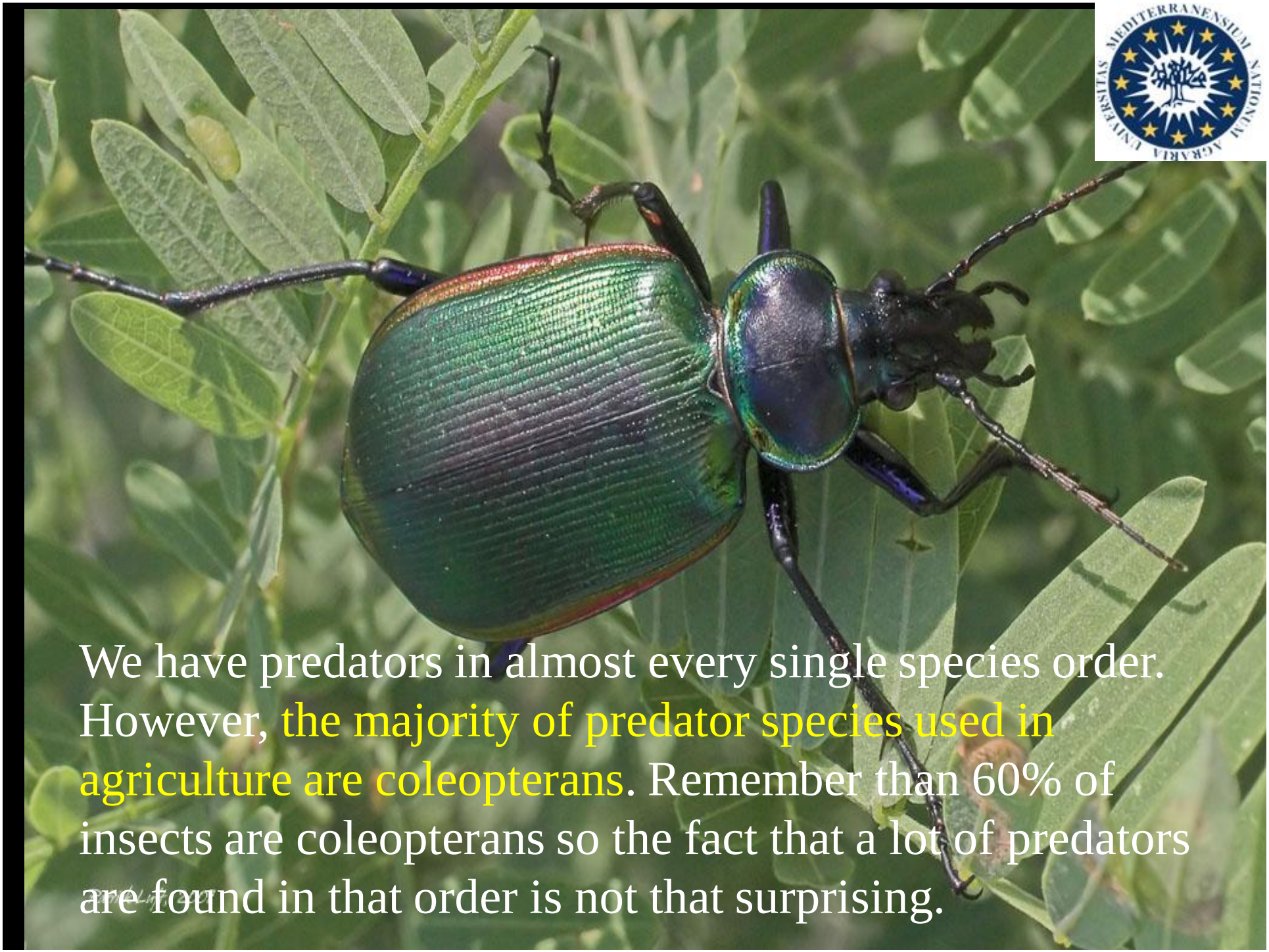
**Predators**.

These are organisms which attack and feed on a number of individuals of the pest. Some of them are predators during their entire life cycle (phytoseids, mirids, coccinelids, antocorids), while others only in the larval stage. Predators are further divided in:

- Ø - specialist predators, which live on one or on a small number of species
- Ø - generalist predators or polyphagous, which can live on several species

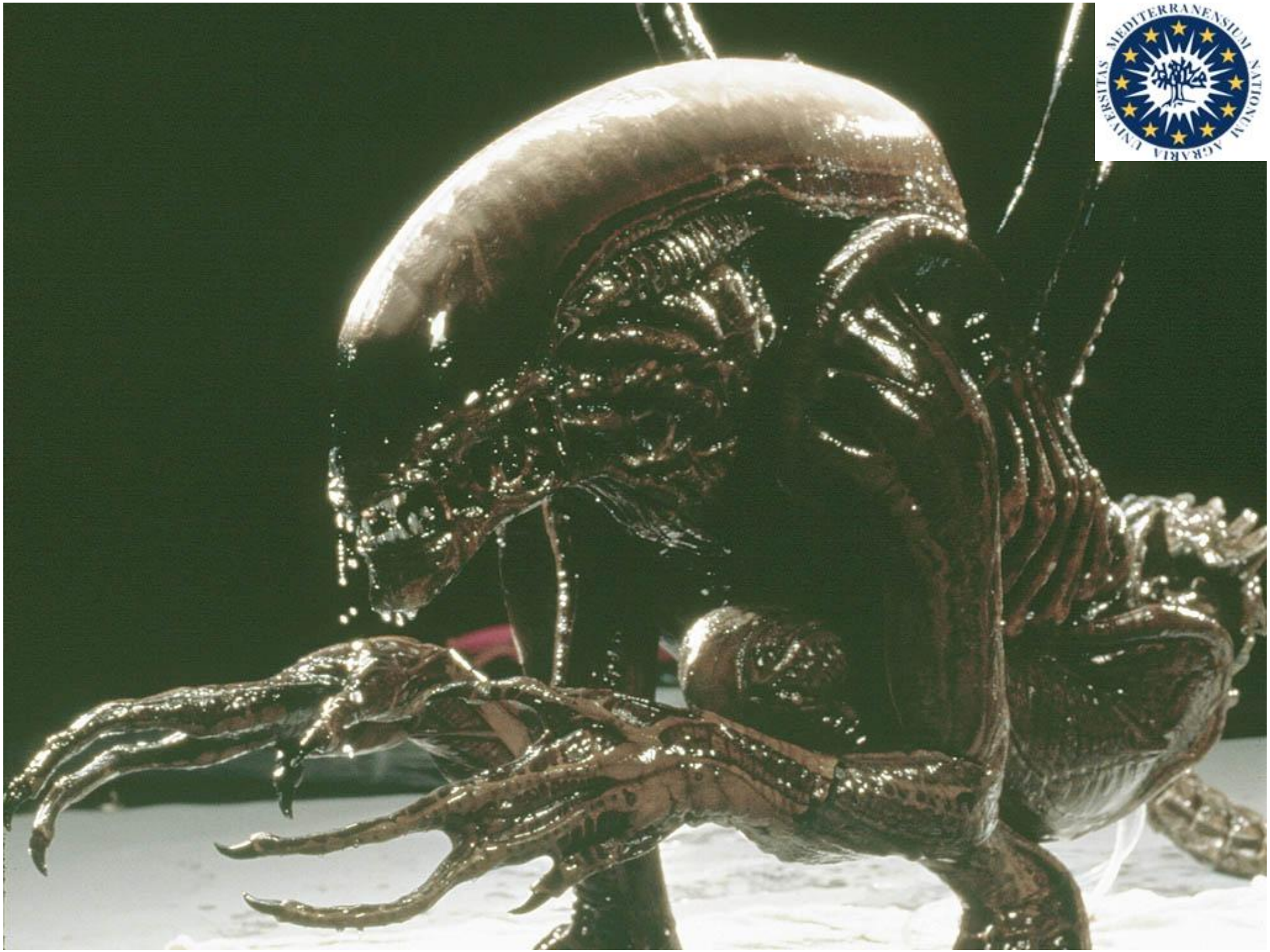
- Predators have the advantage over parasitoids in that each individual consumes a number of prey during their lifetime and, unlike parasitoids, the immature stages are also actively searching for and consuming prey pest species.
- Among the most common predators of insect pests are beetles, predatory bugs, crysopids and the syrphid larvae.


Photo Y.Barbier



We have predators in almost every single species order. However, the majority of predator species used in agriculture are coleopterans. Remember than 60% of insects are coleopterans so the fact that a lot of predators are found in that order is not that surprising.

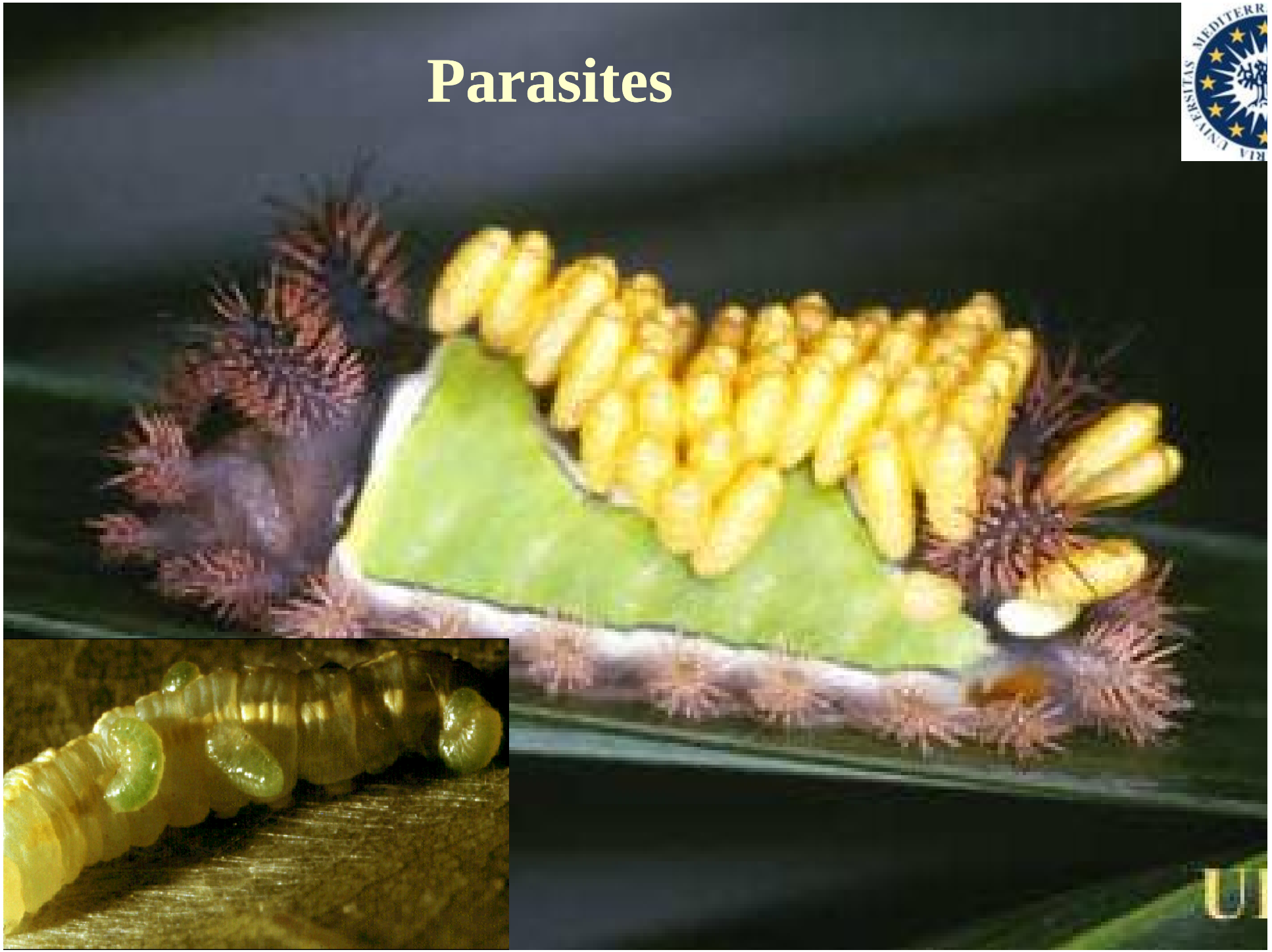
Insect predators can have sucking mouthparts.



# Qualities of Good Predators

1. Considerably larger in size than the prey. Why?
2. Feed in juvenile stage as well as in the adult.
3. Focused feeding habits - specific predators are more effective than general feeders.
4. Predators must be able to switch to an alternative food source when prey populations are reduced.
5. Must be able to adapt to local environmental conditions (temp, rainfall, seasonal changes, etc.)

# Parasites

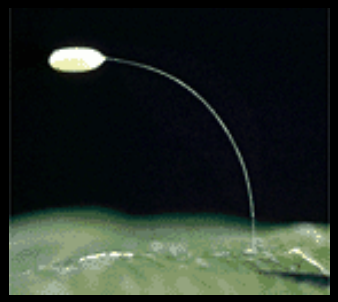


# Predators

Eggs

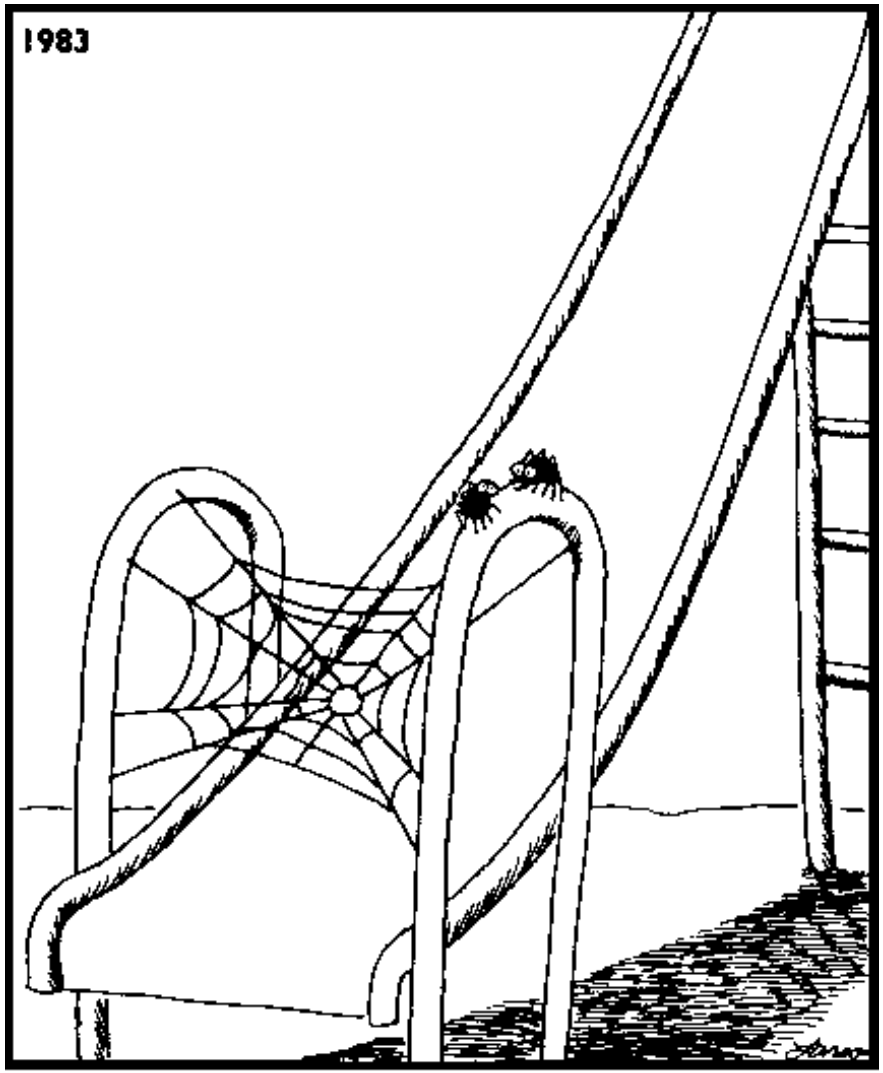
Larvae

Adults



# Biological Control

- The use of living organisms to control pests



"If we pull this off, we'll eat like kings."

- **Predators**
- Parasites
- **Parasitoids**
- **Pathogens**

# Parasite

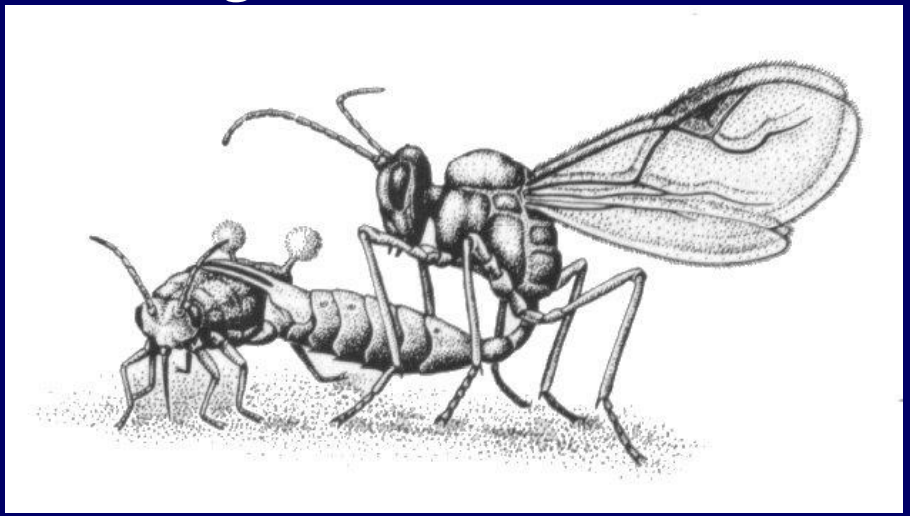
**Parasitized aphids**

**Healthy aphids**

- Very stealthy and often small
- Leave a trail of bodies
- Very specialized
- Develop from eggs laid in or on host

# Parasitoids

- Endo and Ecto parasitoids
- Parasitoid larvae are the ones feeding
- Solitary or gregarious
- Multiple parasitism
- Superparasitism



- Egg, larval, pupal and adult parasitoids

# Parasitoids

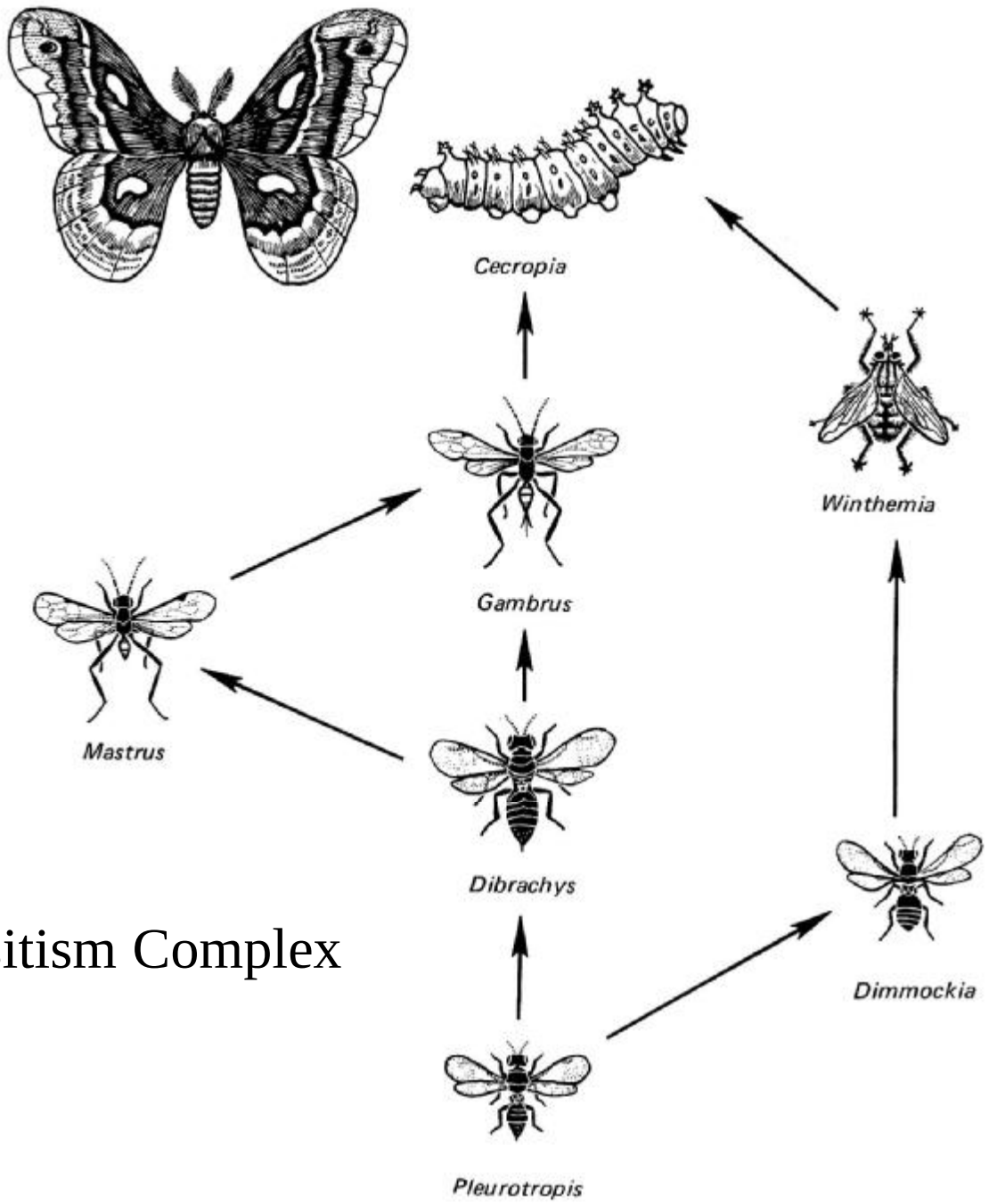
- Generally a non-social wasp (braconids and ichneumonids are commonly used) or a tachinid fly
- Egg(s) are laid on/into host by female using a modified stinger (ovipositor)
- Larvae hatch and consume tissues of prey.
- Move to surface of prey, pupate and emerge as adults

- Parasitoids can also be endoparasitoids. That is, parasitoids which eggs are placed inside their host bodies.
- Parasitoids that oviposit and let the host keep feeding and functioning quasi-normally are referred as **koinobionts.**

Parasitoids that paralyze their hosts leaving them in a state of “suspended animation” are referred as idiobionts.

# Variations in Parasitism

- **Hyperparasitism**, parasite of a parasite (of a….up to 7 levels!)
- **Superparasitism**, mulitple eggs from one or more individuals of the same parasitoid species in a single host.
- **Multiparasitism**, eggs from more than one species. Many parasites have been shown to protect themselves from competition with larvae of other parasitic species. It is relatively rare to find more than one species of parasitoid in a single host individual.

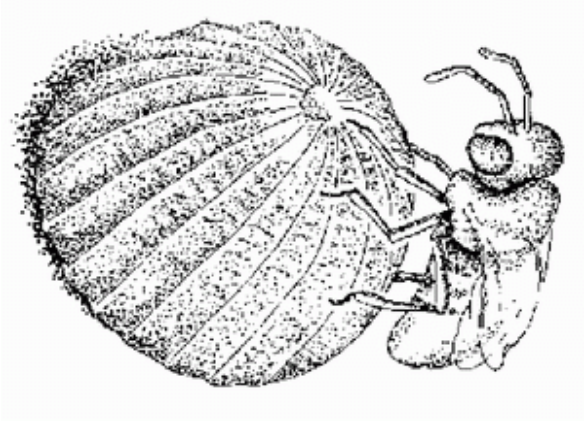



# Hyperparasitism Complex

from Evans, 1984

# How to avoid superparasitism

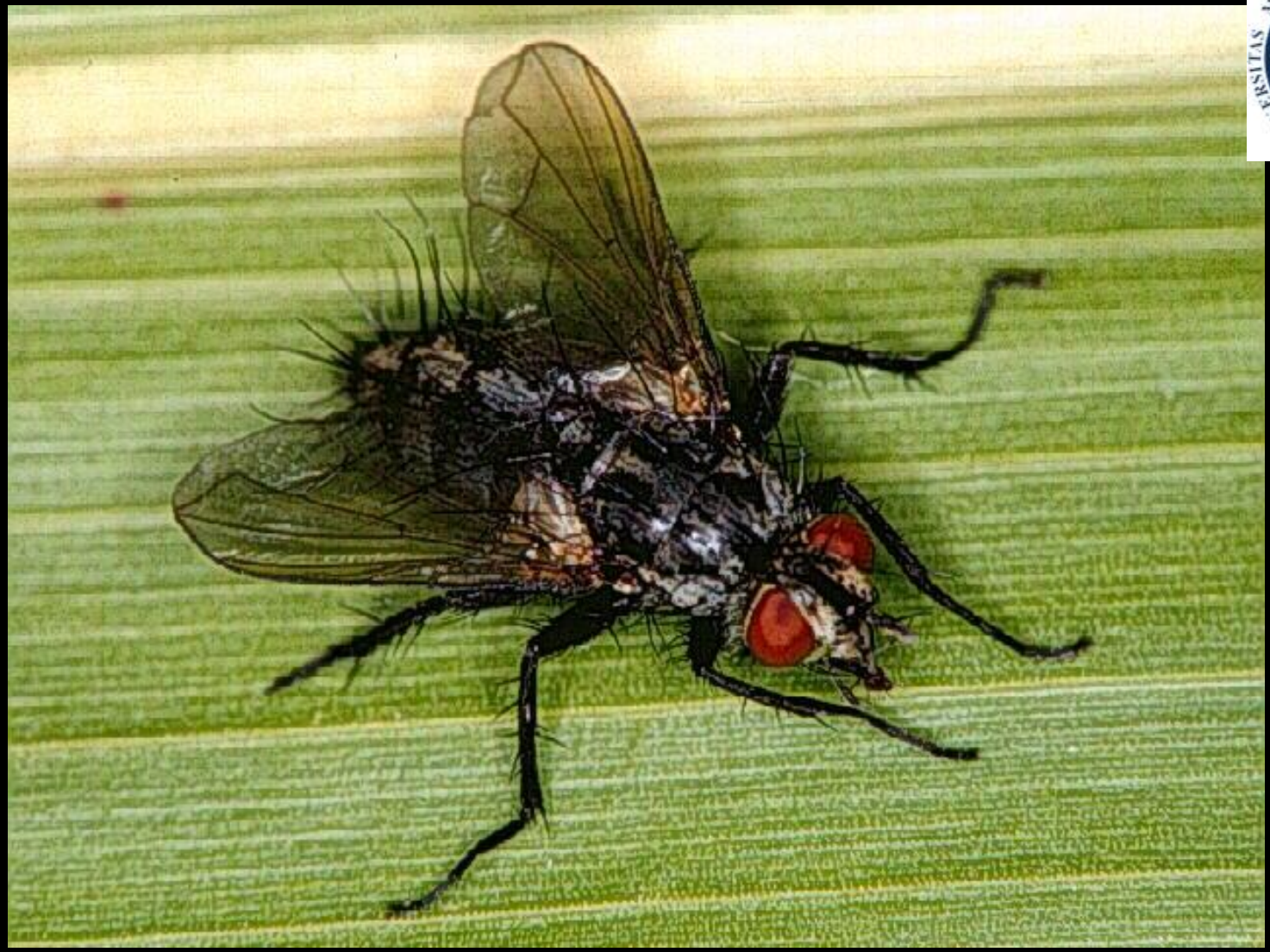
- Adult wasp leaves cue on host egg
- New female avoids
- Why leave a mark?



**Trichogramma on its host egg**

# Parasitoids can attack eggs, larvae, pupa or even adults.

They can be ectoparasitoids. That is, parasitoids which larvae occur on the external part of the host body.



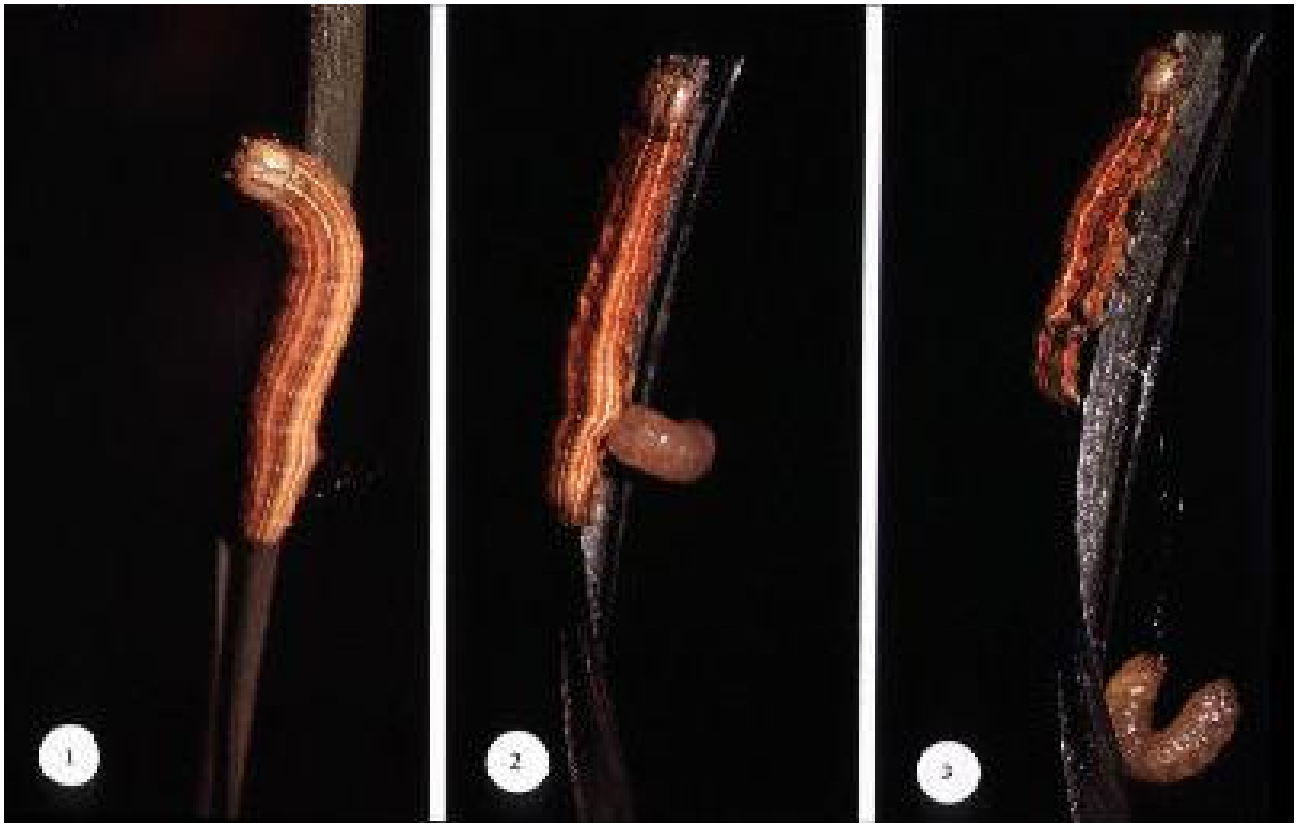
Not all parasitoids are from the order Hymenoptera. Tachinids (Diptera) are important parasitoids in agro-ecosystems.

# Parasitoids can alter host behavior

# Parasitoids can alter host behavior

**Parasites can induce dramatic changes of behaviour in their host species.**

# Endoparasitoid (Braconid) larva emerging from a moth caterpillar



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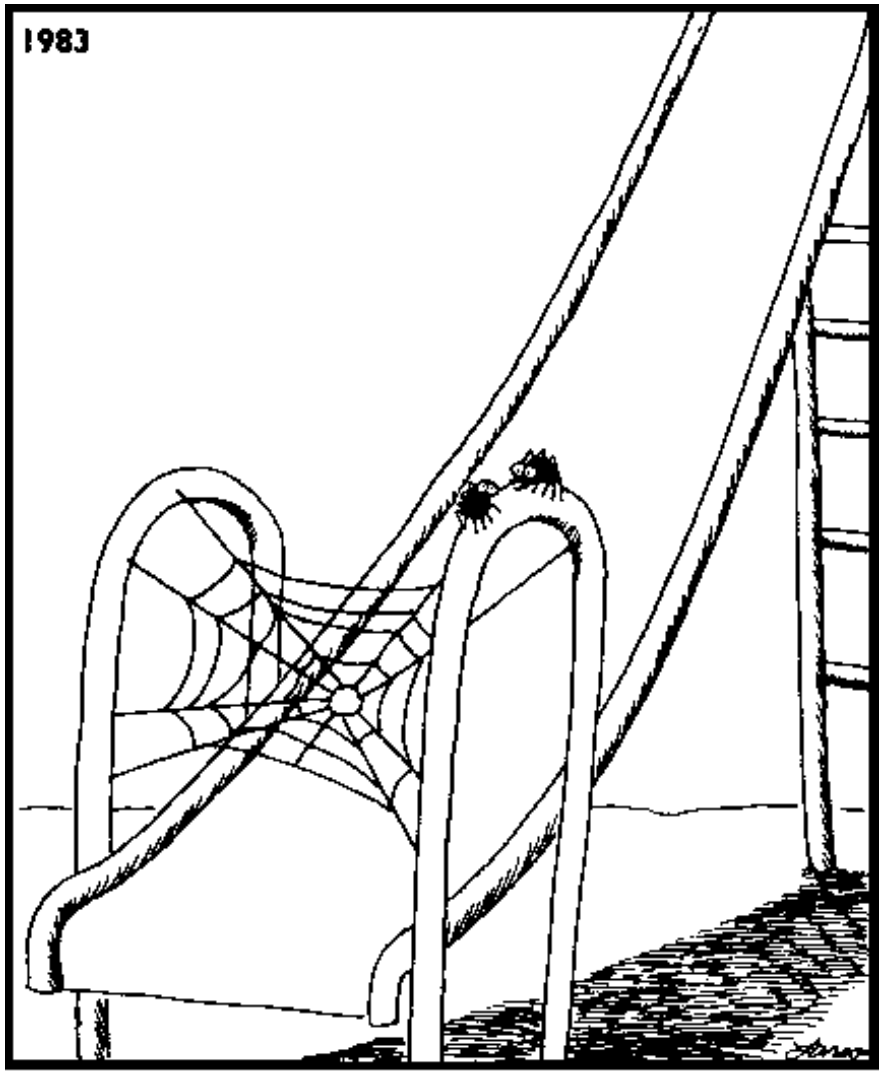


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